Comun. Inst. Geol. e Mineiro, 1994, t. 80, pp. 35-49

Comunicações
Instituto Geológico
e Mineiro

The trilobite *Eoharpes cristatus* Romano, 1975 from the Valongo Formation (Ordovician) of North Portugal

EDUARD H. TAUBER* & JOSÉ M. REIS**

Key-words: Trilobites; Ordovician; Llandeilo; Portugal; *Eoharpes;* Morphology; Stratigraphy; Biozonation; Assemblage; Biogeography; Faunal list.

Abstract: On the basis of new material additional morphological characters of the cephalic region of *Eoharpes cristatus* ROMANO, 1975 from the Valongo Formation of Portugal are described, indicating closer affinities with *Eoharpes guichenensis* HENRY & PHILIPPOT, 1968 from the Traveusot Formation of Brittany than suggested by previously studied material. The thorax and pygidium of the species are described for the first time.

The stratigraphical range of the species is established and the biozonation of the Valongo Formation is revised, adopting the *tournemini/borni* Biozone boundary position as determined by HENRY & CLARKSON (1975). The diversity and relative abundance of the trilobite assemblage in which *Eoharpes cristatus* occurs is presented. The biogeography of the region is discussed and a migration route for *Eoharpes* is proposed. A provisional trilobite faunal list of the Valongo Formation is included.

Palavras-chave: Trilobites; Ordovícico; Landeiliano; Portugal; *Eoharpes;* Morfologia; Estratigrafia; Biozonação; Agrupamento; Biogeografia; Lista faunal.

Resumo: Na base de novo material caracteres morfológicos adicionais da região cefálica da *Eoharpes cristatus* ROMANO, 1975 da Formação de Valongo de Portugal são descritos, indicando afinidades mais próximas com a *Eoharpes guichenensis* HENRY & PHILIPPOT, 1968 da Formação de Traveusot na Bretanha do que os sugeridos por material anteriormente estudado. O tórax e o pigídio da espécie são pela primeira vez descritos.

A extensão estratigráfica desta espécie é estabelecida e a biozonação da Formação de Valongo é revista, adaptando o limite da Biozona *tournemini/borni* determinado por HENRY & CLARKSON (1975). A diversidade e relativa abundância das trilobites do agrupamento onde *Eoharpes cristatus* ocorre e apresentada. Discute-se a biogeografia da região e é proposta uma rota de migração. É incluida uma lista faunal provisória de trilobites da Formação de Valongo.

INTRODUCTION

The genus *Eoharpes* includes five species which range from Llanvirn to probably early Caradoc in age. It was redescribed by WHITTINGTON (1949) who included only two species; *Eoharpes primus* (BARRANDE, 1856) from the Šárka Formation of Bohemia which is of Llanvirn age and *Eoharpes benignensis* (BARRANDE, 1872) from the Dobrotivá Formation of Bohemia which is Llandeilo (Dobrotivian, HAVLIČEK, 1982, P. 113) in age.

Since then three closely related species, restricted to the Ibero-Armorican domain, were described, respectively: *Eoharpes guichenensis* HENRY & PHILIPPOT (1968), which occurs in the upper part of the Traveusot Formation of Brittany and is of Llandeilo age, *Eoharpes cristatus* ROMANO (1975) from the middle part of the Valongo Formation of Portugal, also Llandeilo in age, and more recently *Eoharpes macaoensis* ROMANO & HENRY (1982) from the Queixoperra Member of the Cabeço do Peão Formation of Portugal (YOUNG, 1988), which is probably of early Caradoc age.

* Rua Joaquim António de Aguiar, n.º 38-2.º, PORTO
** Rua S. Roque de Lameira, n.º 2250 -1.º, PORTO

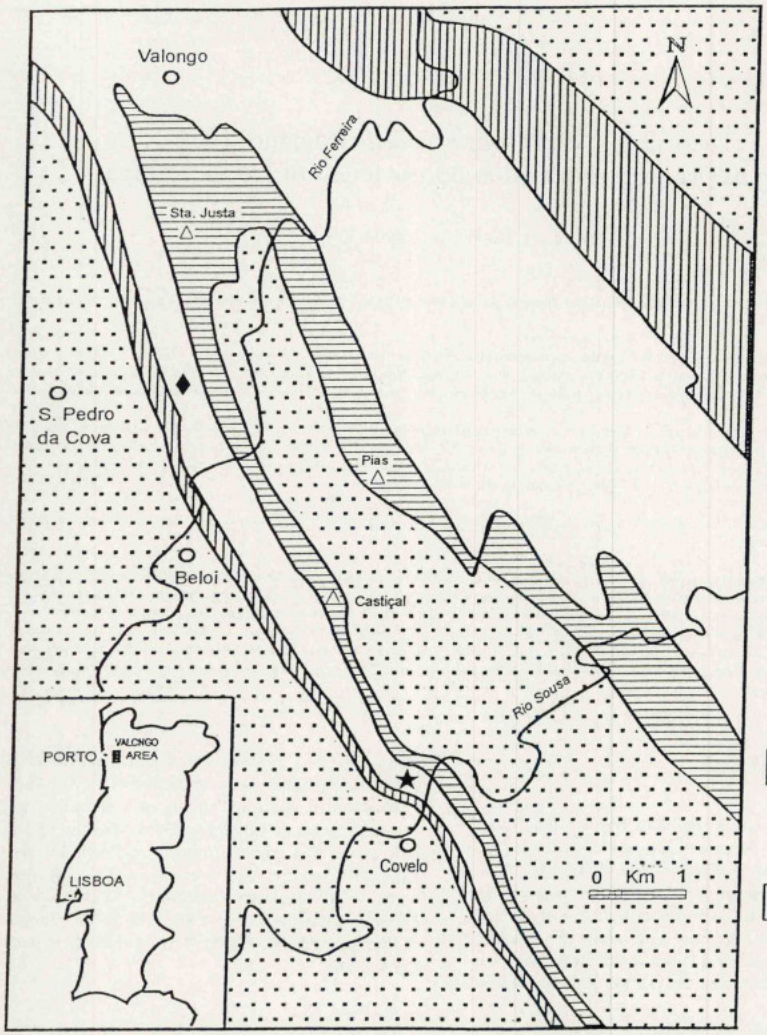


Fig. 1 — Simplified geological map of the Valongo Area (after MEDEIROS *et al.*, 1980; Geological map of Portugal, sheet 9-D).

In his «Système Silurique de Portugal» NERY DELGADO (1908, p. 106) included an extensive faunal list of the formation, and although he did not figure or describe most of the material, the collection on which his faunal list was created is preserved in the «Instituto Geológico e Mineiro» in Lisbon.

The Valongo Formation was named by ROMANO and DIGGENS (1973-74), and a restricted faunal list of the formation was included in a further work on the Ordovician biostratigraphy of Portugal by ROMANO (1982, p. 96). Recent studies on the trilobite faunas from the Valongo Formation have been made by ROMANO (1990, 1991).

A sample system was developed to analise the numerical trilobite variation through the Valongo Formation. A sample volume of approximately 0.5 m^3 of rock obtained a sufficient number of trilobite remains to be representative for an assemblage. We present here the data concerning diversity and relative abundance of the trilobite assemblage where *Eoharpes cristatus* occurs.

SYSTEMATICS

Suborder *Harpina* WHITTINGTON, 1959
Family *Harpetidae* HAWLE & CORDA, 1847
Genus *Eoharpes* RAYMOND, 1905

Type sp. *Harpes primus* BARRANDE, 1856 from the Šárka Formation (Llanvirn) of Osek, near Rokycany, West Bohemia.

Eoharpes cristatus ROMANO, 1975

Plate I, Figs. 1-6; Plate II, Figs. 1-5.

- 1975 *Eoharpes cristatus* sp. nov. ROMANO pp. 28-31, Pl. A, figs. 1-4.
- 1982 *Eoharpes cristatus* ROMANO, 1975. ROMANO & HENRY, pp. 629-631.

DIAGNOSIS

(Emended from ROMANO, 1975 and ROMANO & HENRY, 1982). A species of *Eoharpes* with the following main characteristics: Glabella with faint S1 furrow, S2 and S3 furrows poorly developed. Cheek lobes convex with anastomizing, radiating genal caecae, eye ridge and adaxial part of alar ridge prominent, genal ridge occasionally visible. Fringe with randomly arranged pits, larger and better ordered in the outermost arc of brim. Thorax with 13, possibly 14 segments. Pygidium with 2 segments and a terminal piece.

TYPE AND FIGURED MATERIAL

Holotype: M. Romano collection I, internal and corresponding external mould of cephalon. Hypotypes: E. H. Tauber collection, external mould SPC IIx 04192 of complete carapace and external mould COV I 02194 of cephalon-thorax. J. Reis collection, external mould SPC IIx 91070 of cephalon. Other figured material: E. H. Tauber collection, external mould SPC IIx 03292 of cephalon and external mould COV I 00791 of cephalon-thorax. J. Reis collection, internal mould SPC IIx 92015 of cephalon and external mould COV I 94062 of cephalon.

OTHER MATERIAL

2 cephala-thorax, external and internal moulds COV I 01194 and external mould COV I 94064. 9 cephala; external and internal moulds SPC IIx 91075, COV I 94063 and COV I 93042; external moulds SPC IIx 00892, SPC IIx 03692 and COV I 00893; internal moulds COV I 93044, COV I 93046 and COV I 00993.

HORIZON AND LOCALITIES

All material from the middle part of the *tournemini* Biozone (see biozonation), Llandeilo in age.

Type locality, Valongo Formation A5/6. Road section, east of road, near Beloi, 5.5 km SSE. of Valongo. Locality SPC IIx, Valongo Formation, Serra de Santa Justa 41°56.570 M. North, 5°42.530 M. East. Locality COV I, Valongo Formation, Serra do Castiçal, 41°52.050 M. North, 5°44.800 M. East. Coordinates taken from the Military map of Portugal, Serie M 888, no. 123, Ed. 3, S.C.E.P. 1977 (1986 reprint).

Holotype and figured material deposited in the «Instituto Geológico e Mineiro» in Lisbon.

REMARKS

Cephalon - Glabella marked by deep axial furrow, anteriorly bluntly rounded. S1 furrow short and faint, S2 and S3 furrows occasionally visible. Occipital furrow laterally strongly developed, fading medianly. Occipital lobe wider than glabella

Well developed alar ridge originates at midlength of the glabella, extending postero-laterally and disappearing at the abaxial part of the ala, where it seems to branch, merging into the genal caecae. Alar furrow, occasionally visible, curving inwards, dying out in the direction of the pre-glabellar furrow.

Eye ridge well developed, originating at the upper third of the glabella from where it runs slightly rearwards to the eye tubercle which it meets anteriorly. Eye tubercle large, situated on highest part of cheek lobes.

Genal ridge (faint, and only occasionally visible) originates in the postero-lateral corner of the eye tubercle; after curving slightly outward, it runs almost straight to near the inner margin of the fringe where it disappears.

Brim with a maximum of six to seven pits across its width, pits in the outer arc larger and better ordered than in the rest of brim. External rim wide, and possibly ornamented with fine tubercles. Well-marked girder separates brim from genal roll which has about four

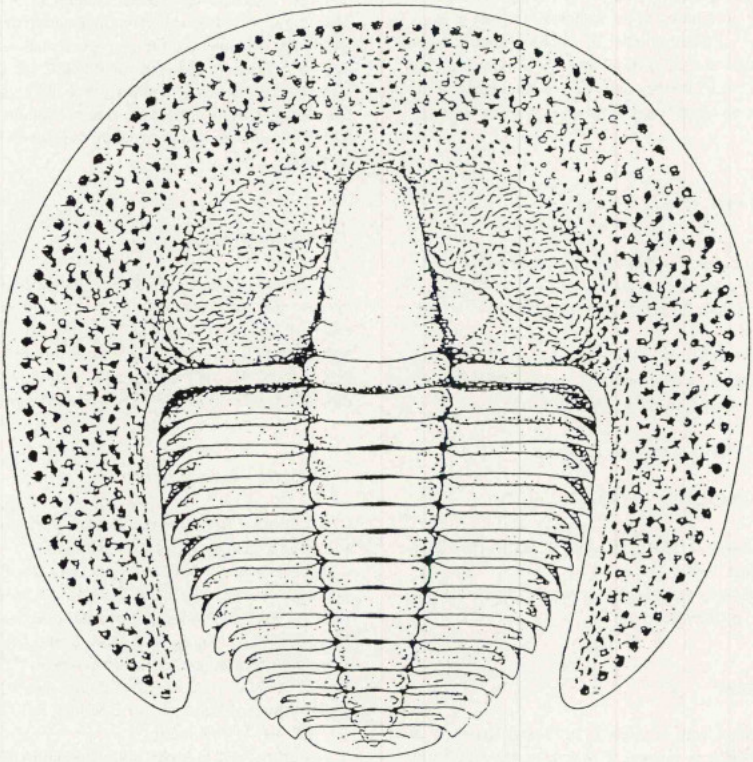


Fig. 2—Reconstruction of *Eoharpes cristatus* ROMANO, 1975 by J. REIS (x 6).

small pits across its width, randomly arranged as in the brim. Internal rim of genal roll prolongation wide and apparently smooth.

Thorax - The thorax agrees in general with the descriptive notes given for *Eoharpes? cristatus* by ROMANO (1975, p. 33-34), who noted a minimum of 14 thoracic segments. A maximum of 13 segments are present in the material figured here. Variation in number of thoracic segments seems to be common in this genus, as 14 to 15 segments are present in *Eoharpes benignensis* (WHITTINGTON, 1949, p. 226).

Pygidium - The pygidium appears to be similar to that of *Eoharpes benignensis* (see discussion WHITTINGTON, 1949, pp. 226-227) and has a posteriorly smoothly rounded axis, with two axial furrows and their corresponding rib furrows in the pleural region.

CONCLUSIONS

The species *Eoharpes cristatus* shows eye ridges like all other species of the genus. A genal ridge is recognized as in *Eoharpes guichenensis* to which it is closely related. The larger pits in the outermost arc of the brim in *Eoharpes cristatus* serve to separate the two species.

The differences between *Eoharpes macaoensis* and *Eoharpes cristatus* are less marked, the pits in the outer arc of the brim in *Eoharpes cristatus* are proportionally larger than those of *Eoharpes macaoensis* and the pits in the rest of brim seem to be more randomly arranged. Ornamentation in general is better developed in *Eoharpes macaoensis*, especially on the surface of the glabella. Better preserved and less deformed specimens of both species are required.

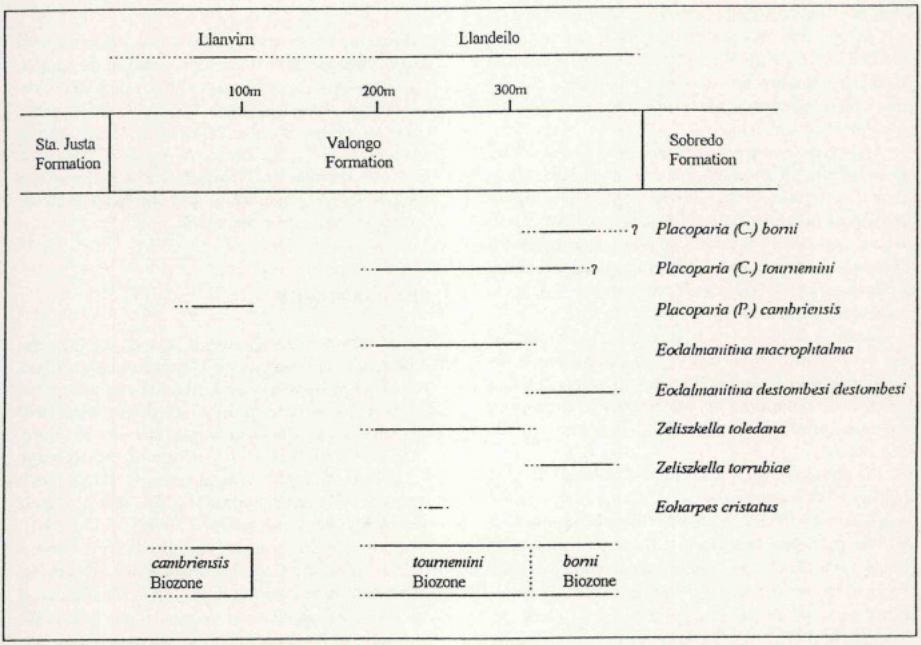


Fig. 3 — Generalized stratigraphy and biozonation of the Valongo Formation, near San Pedro da Cova (see Fig. 1).

In the opinion of the authors the «concentric ridge lying on the upper lamella internal to the outermost arc of pits on posterior part of genal prolongation of brim» (ROMANO, 1975, p. 30) is a preservational feature and may not be a morphological character of this species.

BIOSTRATIGRAPHY

Following the work of HAMMANN (1971a) and HENRY & CLARKSON (1975), three *Placoparia* Biozones have been recognized in the Valongo Formation (ROMANO, 1976).

HENRY & CLARKSON (1975) noted the possible coexistence in Brittany of *Placoparia (C.) tournemini* and *Placoparia (C.) borni,* and ROMANO (1976) also noted the overlapping of the stratigraphical ranges of both species in the Valongo Formation of Portugal.

Because of this coexistence the *tournemini/borni* Biozone boundary has proven to be rather unsatisfactorily determined. We agree with HENRY & CLARKSON (1975, Fig. 2) that the base of the *borni* Biozone should be taken at the first appearance of this species because this occurs simultaneously with a faunal exchange in the Valongo Formation.

At the first occurrence of *Placoparia (C.) borni* there is an increase of diversity, and certain elements of the fauna are replaced. This replacement is most easily recognized in the genera *Eodalmanitina* and *Zeliszkella,* where *Eodalmanitina macrophtalma* and *Zeliszkella toledana* only occur in the *tournemini* Biozone, *Eodalmanitina destombesi destombesi* and *Zeliszkella torrubiae* only in the *borni* Biozone (see Fig. 3).

Eoharpes cristatus occurs only in the middle part of the *tournemini* Biozone and does not persist up to the *tournemini/borni* Biozone boundary. It occurs in a rich assemblage dominated by brachiopods with common trilobites, bivalves and gastropods, and rare ostracods and crinoids.

The details of the sample (see introduction) taken at locality COV I (see horizon and localities) concerning palaeoecology (preservation, size range and orientation) will be published and discussed elsewhere. Here, in Table 1 we present the total of individual remains per species, and the deduced estimated exoskeletons (combined total, of all trilobite parts found, to form one exoskeleton). This recalculation of the data is made because of the high number of individual thoracic segments and free cheeks encountered in some species. We present here both the original counted and recalculated data.

	A	B	C
Placoparia (C.) tournemini	213	117	76
Eccoptochile almadenensis	1	1	0.7
Neseuretus (N.) tristani	26	6	3.9
Prionocheilus mendax	21	12	7.8
Eodalmanitina macrophtalma	10	6	3.9
Zeliszkella toledana	6	4	2.6
Nobiliasaphus nobilis	1	1	0.7
Ectillaenus giganteus	8	4	2.6
Eoharpes cristatus	1	1	0.7
Selenopeltis sp.	1	1	0.7
Uralichas hispanicus	3	1	0.7
Trilobite indet.	9	0	0
Total	300	154	100.3

Table 1 – Reduced data of sample COV I (ke). A = total trilobite remains. B = estimated exoskeletons (see explanation in text). C = percentage of estimated exoskeletons.

From the fifteen species known to occur in the *tournemini* Biozone, eleven are represented in the sample. *Placoparia (C.) tournemini* (76 %) dominates the assemblage. Three species in the sample are restricted to the *tournemini* Biozone, respectively; *Eodalmanitina macrophtalma* (3.9%), *Zeliszkella toledana* (2.6%) and *Eoharpes cristatus* (0.7%) which is a rare element and numerically not important, as only one badly preserved specimen was found in the sample.

BIOGEOGRAPHY

The Ibero-Armorican domain was, during Llanvirn-Llandeilo times, part of the Gondwanaland shelf-sea. The two *Eoharpes* species existing in Llandeilo times in this region were restricted to the deeper water environments; respectively *Eoharpes cristatus* ROMANO, 1975 in the *tournemini* Biozone of the Valongo Formation of North Portugal (zone C, BRENCHLEY, ROMANO & GUTIÉRREZ-MARCO, 1986), and the closely related *Eoharpes guichenensis* HENRY & PHILIPPOT, 1968 of a slightly younger age (ROMANO & HENRY, 1982, p. 629 stated that «It is found with a rich trilobite assemblage corresponding to the top of the biozone of *Placoparia (Coplacoparia) tournemini* and base of the *P. (C.) borni* Biozone») from the Traveusot Formation of Brittany (association 2, HENRY, 1980, Fig. 81).

	BIOZONES		
	camhriensis	*tournemini*	*borni*
1. *Placoparia (Placoparia) cambriensis* HICKS, 1875	*		
2. *Placoparia (Coplacoparia) tournemini* ROUAULT, 1847		*	*
3. *Placoparia (Coplacoparia) borni* HAMMANN, 1971a			*
4. *Eccoptochile mariana* (VERNEUIL & BARRANDE, 1856)			?
5. *Eccoptochile almadenensis* ROMANO, 1980		*	*
6. *Pateraspis mediterranea* (HAMMANN, 1972)	*		
7. *Valongia wattisoni* (CURTIS, 1961)			?
8. *Neseuretus (Neseuretus) tristani* (BRONGNIART, 1822)		*	*
9. *Neseuretus (Neseuretus)* sp.	*		
10. *Salterocoryphe salteri* (ROUAULT, 1851)		*	*
11. *Salterocoryphe* sp.	*		
12. *Colpocoryphe rouaulti* HENRY, 1970		*	*
13. *Colpocoryphe* sp	*		
14. *Prionocheilus mendax* (VANĚK, 1965)		*	*
15. *Prionocheilus* sp	*		
16. *Bathycheilus castilianus* HAMMANN, 1983	*		
17. *Eodalmanitina destombesi destombesi* HENRY, 1966			*
18. *Eodalmanitina macrophtalma* (BRONGNIART, 1822)		*	
19. *Zeliszkella (Zeliszkella) torrubiae* (VERNEUIL & BARRANDE, 1856)			*
20. *Zeliszkella (Zeliszkella) toledana* (HAMMANN 1971b)		*	
21. *Retamaspis melendezi* HAMMANN, 1972	*		
22. *Phacopidina* sp.			*
23. *Pterygometopus?* sp.	*		
24. *Nobiliasaphus nobilis* (BARRANDE, 1846)		*	*
25. *Nobiliasaphus hammanni* RÁBANO, 1989b			*
26. *Nobiliasaphus delessei* (DUFET, 1875)	*		
27. *Isabelinia glabrata* (SALTER, 1853)		*	*
28. *Asaphellus* sp.	*		
29. *Ogyginus? forteyi* RÁBANO, 1989b	*		
30. *Parabarrandia crassa* (BARRANDE, 1872)			o
31. *Protolloydolithus* sp.			o
32. *Dionide mareki* HENRY & ROMANO, 1978		*	*
33. *Ectillaenus giganteus* (BURMEISTER, 1843)	*	*	*
34. *Hungioides bohemicus* (NOVAK *In* PERNER, 1918)	*		
35. *Eoharpes cristatus* ROMANO, 1975		*	
36. *Selenopeltis (Languedopeltis) gallica* BRUTON *In* BRUTON & HENRY, 1978			*
37. *Selenopeltis* sp.	o	o	
38. *Geragnostus* sp.	*		
39. *Uralichas hispanicus* (VERNEUIL & BARRANDE, 1856)		*	*

Table 2 — Trilobite faunal list of tbe Valongo Formation.* = material represented in collection of authors. o = material represented in previous publications not yet detected by authors. ? = material represented in previous publications without exact horizon known.

The two named Llandeilo species of the Ibero--Armorican domain are closely related *to Eoharpes primus* (BARRANDE, 1856) from the Šárka Formation of Bohemia which is Llanvirn in age. Existing plate reconstructions (SCOTESE & MCKERROW, 1991) and palaeobiogeographical reconstructions (PARIS & ROBARDET, 1990) agree that Bohemia during Llanvirn--Llandeilo times was part of or at least bordered the Gondwanaland shelf-sea. And indeed, although the typical Gondwanaland shelf-sea genus *Neseuretus* is absent in Bohemia, the faunas of the Ibero-Armorican domain and Bohemia have (at least at generic level) much in common (HAVLÍČEK. & VANĚK, 1966), which suggests a migration of *Eoharpes* along the deeper Gondwanaland shelf-sea margins from Bohemia to the Ibero-Armorican domain.

In probably early Caradoc times the genus migrated «southward» (early Caradoc transgression, ROMANO, 1990) and was represented by the species *Eoharpes macaoensis* ROMANO & HENRY, 1982 in central Portugal, after which the genus disappears from the region.

FAUNAL LIST

Material represented in the collection of the authors and material described in previous publications are here combined in a faunal list and divided into the three *Placoparia* biozones as adapted in this paper (see biozonation). At present, a minimum of 39 species are known to occur in the Valongo Formation.

All material in previous publications indicated as «the top of the *tournemini* Biozone and the base of the *borni* Biozone» is, according to the biozonation definition accepted in this paper, included in the *borni* Biozone and translated as «the base of the *borni* Biozone where *Placoparia (C.) tournemini* still occurs» (equivalent to the *hupei* Sub-biozone, RÁBANO, 1989a, p. 325).

The following faunal list is far from complete. The faunas from the *cambriensis* Biozone and the poorly fossiliferous rocks between the *cambriensis* and the *tournemini* biozones were only briefly studied, and most material could only be classified at the generic level. Further studies on both existing and new material are in progress.

ACKNOWLEDGEMENTS

We wish to thank Dr. M. Romano for reading an discussing earlier versions of the manuscript, Professor A.M. Galopim de Carvalho for encouragement and logistic support, and Hugo E. Rodrigues Moreira Pinto who found specimen SPC IIx 04192 and kindly offered it to one of us.

REFERENCES

BARRANDE, J. (1846) — Notice préliminaire sur le Système Silurien et les trilobites de Bohême: 97 pp.

—— (1856) — Note sur quelques nouveaux fossiles découverts aux environs de la ville de Rokitzan. *Bull. Soc Géol. France*, **2** (8): 532-538.

—— (1872) — Système silurien du centre de la Bohême. I, Recherches paléontologiques, supplément au vol. 1: 647 pp.

BRENCHLEY, P.J., ROMANO, M. & GUTIÉRREZ-MARCO, J.C. (1986) — Proximal and distal hummocky cross-stratified facies on a wide Ordovician shelf in Iberia: *In* KNIGHT, R.J. & MCLEAN, J.R. (eds). Shelf sands and sandstones. *Can. Soc. Petrol. Geol. Mem.*, **2**, 241-255.

BRONGNIART, A. (1822) — Les Trilobites. *In* BRONGNIART, A. & DESMAREST, A. - G., Histoire naturelle des Crustacés fossiles, sous les rapports zoologiques et géologiques: 65 pp.

BRUTON, D.L. & HENRY, J. - L. (1978) — *Selenopeltis* (Trilobita) from Brittany and its distribution in the Ordovician. *Géobios*, **11** (6): 893-907.

BURMEISTER, H. (1843) — Die Organisation der Trilobiten aus ihren lebenden Verwandten entwichkelt; nebst einer systematische Übersicht aller zeither beschriebenen Arten: 147 pp.

CURTIS, M.L.K. (1961) — Ordovician trilobites from the Valongo area, Portugal. Cheiruridae, Pliomeridae and Dionididae. *Bol. Soc. Geol. Portugal*, Lisboa, **14**: 1-18.

DELGADO, J.F.N. (1908) — Système silurique du Portugal; étude de stratigraphie paléontologique. *Mem. Commn. Geol. Portugal*, Lisboa: 1-245.

DUFET, H. (1875) — Note sur les déformations des fossiles contenus dans les roches schisteuses, et sur la détermination de quelques espéces du genre Ogygia. *Ann. École Norm. Sup. Mines*, **2** (4): 183-l90.

HAMMANN, W. (1971a) — Die Placopariinae (Trilobita, Cheirurina; Ordovizium). *Senck. lethaea*, **52** (1): 53-75.

—— (1971b) — Stratigraphische Einteilung des spanischen Ordoviziums nach Dalmanitacea und Cheirurina (Trilobita). *Mém. Bur. Rech. Géol Min. Paris. (B. R. G. M.)*, **73**: 265-272.

—— (1972) — Neue propare Trilobiten aus dem Ordovizium Spaniens. *Senck. lethaea*, **53** (5): 371-381.

—— (1983) — Calymenacea (Trilobita) aus dem Ordovizium von Spanien; ihre Biostratigraphie, Ökologie und Systematik. *Abh. senckenberg. naturforsch. Ges.*, **542**: 1--177.

HAVLÍČEK, V. (1982) — Ordovician in Bohemia: development of the Prague Basin and its bentic communities. *Sbor. geol. Věd Geol.*, **37**: 103-136.

—— & VANĚK, J. (1966) — The biostratigraphy of the Ordovician of Bohemia. *Sbor. geol. Věd. paleont.*, **8**: 7-69.

HENRY, J. - L. (1966) — Sur un nouveau *Phacopina* (Trilobite) de l'Ordovicien de Bretagne. *Bull. Soc. Géol. France*, **7** (7): 558-562.

—— (1970) — Quelques Calymenacea (Trilobites) de l'Ordovicien de Bretagne. *Ann. Paléont., Invertébrés*, **56** (1): 1-27.

—— (1980) — Trilobites ordoviciens du Massif Armoricain. *Mém. Soc. Géol. Minéral. Bretagne*, **22**: 1-250.

—— & CLARKSON, E.N.K. (1975) — Enrollment and coaptations in some species of the Ordovician trilobite genus *Placoparia*. *Fossils and Strata*, **4**: 87-95.

—— & PHILIPPOT, A. (1968) — Nouvelles découvertes paléontologiques dans l'Ordovicien moyen d'Ille-et-Vilaine. *C.R. Acad Sci.*, **266**: 2187-2189.

—— & ROMANO, M. (1978) — Le genre *Dionide* BARRANDE, 1847 (Trilobite) dans l'Ordivicien du Massif Armoricain et du Portugal. *Géobios*, **11** (3): 327-343.

HICKS, H. (1875) — On the succession of the ancient rocks in the vicinity of St. Davids, Pembrokeshire, with special reference to those of the Arenig and Llandeilo groups, and their fossil contents. *Quart. J. geol. Soc. Lond.*, **31**: 167-195.

MEDEIROS, A.C., PEREIRA, E. & MOREIRA, A. (1980) — Carta geológica de Portugal, esc. 1:50.000, Folha 9-D, Penafiel. *Serv. Geol. Portugal*, Lisboa.

PARIS, F. & ROBARDET, M. (1990) — Early Palaeozoic palaeobiogeography of the Variscan regions. *Tectonophysics*, **177**: 193-213.

PERNER, J. (1918) — Die trilobiten der Zone D-d1 von Prag und Umgebung. Eine Manuskriptstudie des Prof. O. NOVAK, Redigiert und mit Ergänzungen von J. PERNER. *Česká Akad. C. Frant. Jos. pro vedy. slovenost a umeni v Praze*, **2**: 1-51.

RÁBANO, I. (1989a) — Trilobites del Ordovícico Medio del sector meridional de la zona centroibérica española. Parte I: Yaciementos, bioestratigrafía y aspectos paleobiogeográficos. *Bol. Geol. Min.*, **100** (3): 307-338.

—— (1989b) — Trilobites del Ordovícico Medio del sector meridional de la zona centroibérica española. Parte II: Agnostina y Asaphina. *Bol. Geol. Min.*, **100** (4): 541-609.

ROMANO, M. (1975) — Harpid trilobites from the Ordovician of North Portugal. *Com. Serv. Geol. Portugal*, Lisboa, **59**: 27-36.

—— (1976) — The trilobite genus *Placoparia* from the Ordovician of the Valongo area, North Portugal. *Geol. Mag.*, **113** (1): 11-28.

—— (1980) — The trilobite *Eccoptochile* from the Ordovician of northern Portugal. *Palaeontology*, **23** (3): 605-616.

—— (1982) — The Ordovician biostratigraphy of Portugal – A review with new data and re-appraisal. *Geol. J.*, **17**: 89-110.

—— (1990) — The trilobite Protolloydolithus from the middle Ordovician of North Portugal. *Palaeontology*, **33** (2): 487-493.

—— (1991) — Trilobites from the Ordovician of Portugal. *Palaeontology*, **34** (2): 329-355.

—— & DIGGENS, J.N. (1973-74) — The stratigraphy and structure of Ordovician and associated rocks around Valongo, North Portugal. *Com. Serv. Geol. Portugal*, Lisboa, **57**: 23-50.

—— & HENRY, J. - L. (1982) — The trilobite genus *Eoharpes* from the Ordovician of Brittany and Portugal. *Palaeontology*, **25** (3): 623-633.

ROUAULT, M. (1847) — Extrait de Mémoire sur les Trilobites du département d' Ille-et-Vilaine. *Bull. Soc. Géol. France*, **2** (4): 309-328.

—— (1851) — Mémoire sur le terrain paléozoïque des environs de Rennes. *Bull. Soc. Géol. France*, **2** (8): 358-399.

SALTER, J.W. (1853) — Notes on the Trilobites. Appendix C. *In* RIBEIRO, C.: On the Carboniferous and Silurian formations of the neighbourhood of Bussaco in Portugal. *Quart. J. Geol. Soc. Lond.*, **9**: 158-160.

SCOTESE, C.R. & MCKERROW, W.S. (1991) — Ordovician plate tectonic reconstructions. *In* BARNES, C.R. & WILLIAMS, S.H. (eds), Advances in Ordovician Geology. *Geol. Surv. Canada*, **90** (9): 271-282.

VANĚK, J. (1965) — New species of the suborder Calymenina Swinnerton, 1915 (Trilobita) from the Barrandian area. *Sbor. geol. Věd. paleont.*, **6**: 21-37.

VERNEUIL, E. & BARRANDE, J. (1856) — Description des fossiles trouvés dans les terrains silurien et dévonien d'Almaden, d'une partie de la Sierra Morena et des Montagnes de Tolède. *Bull. Soc. Géol. France*, **12**: 864-1025.

WHITTINGTON, H.B. (1949) — Redescription of the trilobite *Eoharpes* RAYMOND 1905. *Quart. J. Geol. Soc. Lond*, **104**: 221-228.

—— (1950) — British trilobites of the family Harpidae. *Palaeontogr. Soc. (Monogr.)*, 1-55.

YOUNG, T.P. (1988) — The lithostratigraphy of the upper Ordovician of central Portugal. *Journ. Geol. Soc. Lond*, **145**: 377-392.

PLATES

PLATE I

Fig. 1 - Latex cast of external mould of cephalon COV I 94062 (x 6).

Fig. 2 - Latex cast of external mould of cephalon SPC IIx 03292 (x 3.4).

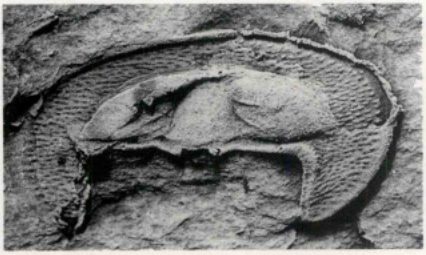
Fig. 3 - Internal mould of cephalon SPC IIx 92015 (x 2.9).

Fig. 4 - Latex cast of external mould of cephalon-thorax COV I 00791 (x 3.3).

Fig. 5 - Latex cast of external mould of cephalon-thorax, hypotype COV I 02194 (x 2.6).

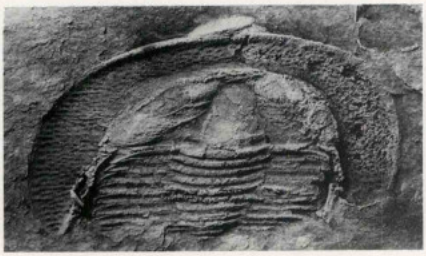
Fig. 6 - Latex cast of external mould of cephalon, hypotype SPC IIx 91070 (x 3.4).

For details of localities and horizon see text. All material whitened with ammonium chloride before photographing.



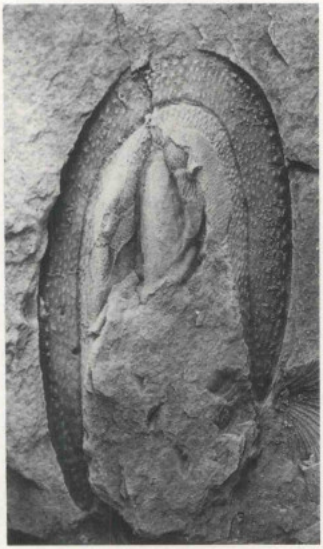
1

2



3

4



5

6

PLATE II

Fig. 1 - Latex cast of external mould of carapace, hypotype SPC IIx 04192 (x 3.8).

Fig. 2 - Latex cast of external mould of cephalon, hypotype SPC IIx 91070 (see Plate I, Fig. 6), accompanied by *Placoparia (C.) tournemini, Eodalmanitina macrophtalma and Zeliszkella toledana* (x 1.1).

Fig. 3 - Latex cast of external mould of cephalon-thorax, hypotype COV I 02194 (see Plate I, Fig. 5), showing S1 and faint indication of S2 and S3 furrows (x 7.8).

Fig. 4 - Latex cast of external mould of carapace, hypotype SPC IIx 04192 (see Plate II, Fig. 1), showing details of pygidium (approximately, x 10).

Fig. 5 - Latex cast of external mould of cephalon, SPC IIx 92015 (see Plate I, Fig. 3), showing details of genal roll (approximately, x 10).

For details of localities and horizon see text. All material whitened with ammonium chloride before photographing.

1

4

2

5

3